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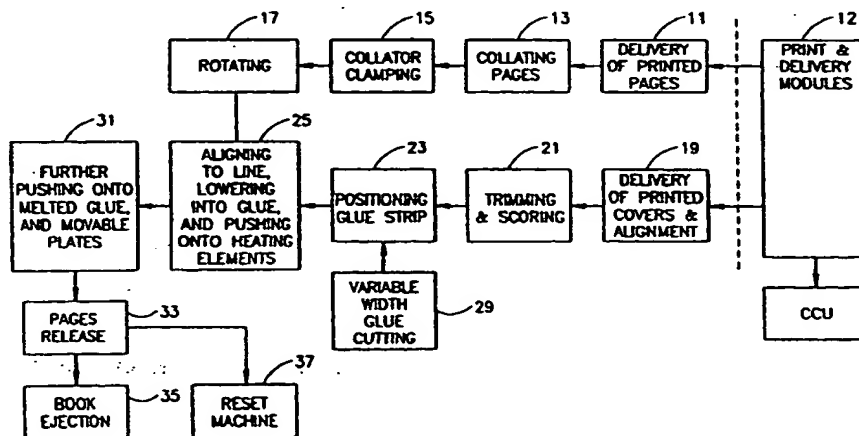
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(54) Title: A PAPERBACK FINISHING MACHINE



(57) Abstract: The invention teaches a paperback book-finishing apparatus comprising a collator (13), a cover trimmer (with optional scorer (21)), a glue cutter (29), and a binder (25, 31). The apparatus can automatically finish books of different thicknesses. The operations of cover trimming, glue cutting and placement, and collating are all carried out by aligning to a common alignment edge. The glue cutter (29) cuts glue strips of variable width and the collator (13) collates printed sheets by synchronized tamping. The apparatus can be used with in-line, on-demand page printers and in-line, on-demand cover printers. The apparatus can be used in book vending machines.

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The perfect binding machines available today fail to address a number of issues. They are usually not fully automatic and do not operate in-line with an on-demand printer. They are usually not compact and would not be suitable for use within the narrow confines of offices or book retailers who produce books using on-demand digital printers. In addition, in these perfect binding machines, both the book's cover and pages usually require trimming after completion of the binding process to achieve trade or paperback book quality. This is an indication that page alignment is inadequately maintained throughout the finishing process.

A finishing machine overcoming these deficiencies is needed for incorporation into paperback book vending machines, office digital printers, or on-demand printing machines found in bookshops. The finishing machines at these locations would be operated by the consumer, office personnel or book retailers. In all instances, the finishing apparatus would be directly linked to an on-demand in-line printer. Such a vending machine is described in Israeli application No. 125389 assigned to the common assignee of the present application, that application being incorporated herein by reference. Such vending machines would enable book dealers to maintain lower hardcopy inventories. They also will help meet demand for out-of-print titles through use of digital book archives.

SUMMARY OF THE INVENTION

The present invention is a compact book finishing apparatus meeting the needs described above. It can be integrated with digital and non-digital

The invention further teaches a book-finishing apparatus as taught above where the collator comprises means for collating the printed sheets into a book block, aligning the edges of the printed sheets to an end surface of the collator and further aligning the book block with the long edge of the cover's center area.

The above apparatus has a collator which comprises a collating means which collates and aligns printed sheets into a book block. The collator comprises a clamping means which clamps the book block when collating is complete and a rotating means which rotates the book block to a position substantially perpendicular to the book cover after the book block has been clamped. Finally, the collator further comprises an aligning means which aligns the book block along the long edge of the center portion of the cover.

The collating means of the apparatus comprises a receiver unit for receiving the printed sheets. The unit further comprises a base and a plurality of restraining elements mounted on the base. The restraining elements form a rectangle generally of the same size as the printed sheets. The collating means further comprises at least one active element which tamps and aligns the printed sheets when they are within the receiver unit. A synchronizer activates the at least one active element when a paper sheet is received in the receiver unit.

The invention further teaches a book-finishing apparatus as taught above for use with an on-demand printing machine.

The apparatus may further comprise a central control unit which is in communication with and controls at least one of the following: the collator, the

BRIEF DESCRIPTION OF THE DRAWINGS

Attention is now directed to the attached drawings, wherein like reference numeral or characters indicate corresponding or like components. In the drawings:

5 FIG. 1 is a block diagram of the operations performed by the invention.

FIG. 2 is an isometric view of the collator in the collation position.

FIG. 3A is an isometric view of the collator and binder in the "collation" position

10 Fig 3B is an isometric view of the collator and the binder with collator full, clamped and rotated downwards.

FIG. 4A is a front view of the trimmed and scored cover.

Fig. 4B is an isometric view of the trimmed and scored cover.

FIG. 5 is an isometric view of the cover trimmer.

FIG. 6 is a section view of the cover trimmer.

15 FIG. 7A is a top view of the cover trimmer, the glue cutter and the binder comprising the invention.

FIG. 7B is a side view of the cover trimmer, the glue cutter and the binder comprising the invention.

FIG. 8A is a side view of the glue cutter using a rotating knife.

20 FIG. 8B is a side view of the glue cutter using a guillotine knife.

FIG. 9 is an isometric view of the binder shown in Figs. 3 and 7.

FIG. 10 is a section view through the binder shown in Fig. 9 with a cover and a glue strip affixed to it

25 Fig. 11 is a section view through the binding module 9 at operation 31 of Fig. 1 showing the pages being lowered into the glue strip.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Reference is made to FIG. 1 which shows the various operations involved in binding a soft cover book. The process begins with the delivery of loose printed sheets (operation 11) from a printer (not shown) followed by their
5 collation by a collator (operation 13). After the last printed page reaches the collator, the collator clamps the pages into a book block (operation 15). The clamped collated book block is rotated (operation 17) so that the book block's spine faces downward.

While operations 11 through 17 are performed, the cover is processed.
10 The cover is printed (printer not shown) and delivered by conveyor or other means (operation 19) to the cover trimmer module (operation 21). The cover is trimmed and optionally scored as explained below and moved on to the glue cutter (operations 23 and 29). The glue cutter cuts a strip of hot-melt glue (operation 29) and positions it on the cover's spine (operation 23). The width of
15 the strip can be varied and depends on the thickness of the book being finished. The strip is then affixed firmly to the cover by applying heat through the cover at several points, usually two points.

The cover, with the strip of glue attached to it, is conveyed to the binding module where the spine of the cover is placed above heating elements.
20 The rotated book block is then lowered and carefully aligned with the spine. The block pushes down on the spine activating the heating elements melting the glue strip (operation 25).

In operation 31, the clamped pages are lowered further onto the affixed glue strip, pushing the cover even further against the hot heating

book block 11 gently, aligning it with the previous pages 134 against the pins 135. The three cylinders 145 then return to their initial positions where they are held in place by brackets 143. The pneumatic cylinders constitute an "active" alignment mechanism synchronized with the entry of the printed sheets. While the above Figure shows three tamping units 145A, 145B, 145C, in other embodiments fewer than three may be acceptable. In some cases even a single tamping unit could successfully align the incoming pages.

Synchronization refers to timing the activation of the pneumatic cylinders 145 with the delivery of the printed sheets. Each cylinder 145 is electronically activated when a detector detects the new page entering the collator. The detector is usually an optical detector. The electronics and detector elements of the synchronization mechanism are not shown in the Figure.

After the incoming sheet is detected and after an appropriate delay to optimize tamping efficiency, the electronically activated cylinders 145 tamp the entering sheet. This is repeated for each individual sheet.

After the last page of the book has been delivered to the collator and the aligning cycle has been performed, the CCU activates the collator clamping mechanism. The CCU causes two pneumatic cylinders 137 to retract. This results in rods 139 pulling on bridge 141, clamping the loose sheets into an aligned stack. Solenoids or any other linear actuator mechanism can activate the rods 139.

At the conclusion of the clamping operation, the CCU activates the collator rotation mechanism. As seen in Fig 3A, the collator 13 is attached by its base plate 127 to two side plates 129. Side plates 129 are connected to two carriages 114 via bearings (not shown) which enable the collator to rotate

to edge 200 shown below in Fig. 7A. The edge also corresponds to the long edge of the rectangular center area of the book cover, the area being coincident with the cover's spine. The position of the book block's other face varies with the book's thickness.

5 The CCU can also control the cover printer, often an in-line, on-demand cover printer. Among other things, it can regulate when the cover printer delivers a cover to the finishing machine. A cover with its printed side facing downward is delivered to the cover trimmer module (hereinafter referred to as CTM). Fig. 4A shows a front view of a finished, scored and trimmed cover
10 19, while Fig 4B is an isometric view of the same cover.

The cover length L corresponds to the length of the printed pages and is fixed for a given setting of the machine. The total width W of the cover and the cover's spine T vary depending on the number of pages in the book being printed and the thickness of the individual pages. The four scores 94, 95 act as
15 hinges with which to fold the cover. The two inner scores 95 are spaced T mm apart and correspond to the thickness of the collated pages. The two outer scores are used as "hinges" to neatly open the book.

Fig. 5 shows an isometric view of the cover trimmer (CTM) 21. Side guides 39 and one or more rubber rollers 41 guide the cover 19. In Fig. 5, only
20 one shaft is shown. The rollers 41 are mounted on motorized shafts 43 with the motor not shown. The rollers grip the cover 19 and push it into the CTM 21.

Fig. 6 shows a section view of the CTM 21. Two parallel shafts 45 are mounted on bearings 47 held in the right side plate 49 and the left side plate 51. Motor 55 bears a pinion 57 that is meshed with gear 59, the latter being
25 attached to the upper shaft 45. An identical gear 59 is attached to the lower

thickness from the archived data, the CCU transfers the information to the CTM which would then adjust T. Alternatively, a sensor that detects the actual thickness of a collated book block can be attached to the collator. The sensor would then transmit this information to the CTM via the CCU, and the CTM would automatically adjust T, the distance between the inner scores 95.

The sensor on the collator can also be in communication with the cover printer (not shown). Instead of printing the entire cover all at once based on archived information from the CCU, the sensor can control printing of the book's cover in stages. The front cover can be printed immediately based on CCU archived data. Data from the sensor on the thickness of the collated book block can then be transmitted via the CCU to the cover printer where printing of the book's spine would be adjusted and varied based on the book title being printed. The back cover can then be printed using additional archived data from the CCU.

Fig. 7A shows a top view of the layout of the CTM 21 of Fig. 6, the glue cutter (GC) module 29 of Figs. 8A, and 8B, and the binding module 9 of Fig. 9. Fig. 7A shows the alignment reference edge 200 discussed previously to which the collator 13 aligns the book block 11 in Fig. 3B. In Fig. 7A, the book cover 19 and movable plates 159 are located at the binding module 9.

Fig. 7B shows another embodiment of the CTM 21, GC 29 and binder 9. The cover 19 and movable plates 159 are shown at positioning station 199. The cover trimming mechanism of Fig. 5 and Fig. 6 shown in Fig. 7A does not appear. Rather, in Fig. 7B, another embodiment of the CTM 21 is shown, one lacking scorers but still including cutters 61 and 75. These latter are positioned immediately after the GC 29. The cover is moved on the travel movement 201

The size of the strip to be cut can be calculated on the basis of the number of pages and the thickness of each page. This data can be stored in the CCU for each individual title and then transmitted to the GC. An alternate embodiment would include a sensor in the collator to measure the thickness of each book block. The sensor would transmit the results of each measurement to the CCU. The CCU would then feed the data to the GC.

When movable plates 159 are activated on travel movement 201, they move the cover 19 with the glue strip 96 affixed to it to the binding module 9 (Fig. 9). This is best seen in Fig. 7B.

Fig. 9 shows the binder base mechanism of the binding module 9 first encountered in Figs. 7A and 7B. Two parallel round shafts 153A, 153B are mounted on the base plate 111 with brackets 151A, 151B respectively. Two plates 159 are mounted between shafts 153A, 153B and are movable on the shafts 153 via sliders 157 and brackets 155. Shafts 153 and sliders 157 as shown in the Figure are well known in the art. Between the plates 159 is a metallic housing 167 which includes electric heaters 168.

In Fig. 9, there are two brackets 166 on base plate 111, each carrying a horizontal pneumatic cylinder 169. The rods of the cylinders 169 are attached to the movable plates 159. When the pneumatic cylinders 169 are activated, they cause the plate 159 to move towards or away from the heating housing 167. The right hand plate 159 is limited in its inward movement by a stop screw 165 and stop nut 164 (seen better in Figs. 10 and 11). Screw 165 and nut 164 align the inner face of the right hand plate 159 with the location of the cutters 99 shown in Figs. 8A and 8B. They also align the inner face of the right hand plate 159 with the location of the wheel cutters 61 shown in Fig. 6 and with the

force the movable plates 159 to press against the spine's sides, folding and closing the cover.

The CCU then deactivates the collator's clamp 141, releasing the book block 11. The collator 13 is raised by motor 124 (Fig. 3A) to its original level.
5 The heaters 168 are turned off and the heater's housing 167 begins to cool. After a short period, the glue 96 solidifies, the pneumatic cylinders 169 retract, and the movable plates 159 release the book's spine. Finally, the CCU causes the finished book to be ejected and resets the machine for the next binding operation. The ejection mechanism is not shown and is not part of this
10 invention.

Figs. 12A and 12B are front and back views of the finishing apparatus in use with an exemplary on-demand digital printer. The printing (Fig. 12B) and finishing (Fig. 12A) functions in the machine are physically separated by partition 199. A print web 180 moves through a digital printer 184, here an ink jet
15 printer. A sheeter 181 cuts the printed web, and the initial sheets, which are unused, drop into the trash bin 182. A glue tape roll 95 is seen as is binding module 9 and a separate cover printer 179. The latter may be an on-demand cover printer. A travel movement 201 on which the movable plates 159 move, similar to the one shown in Fig. 7B, is shown. Fig 12 B does not show any
20 scorers. A completed book delivery system 177 is also shown. A finishing apparatus as in Fig. 12A is easily incorporated into a book vending machine.

The embodiment of the invention discussed above, describes a finishing apparatus which can bind books of only a single length (L in Fig. 4B). The addition of motors and mechanisms however can turn a fixed book size
25 machine into a variable one. For example, in Fig 2, the addition of motors to

use pre-printed covers which can be fed into the travel movement 201 at positioning station 199.

In the preferred embodiment described throughout and seen in Figs 3B and 11, there is rotation and lowering of the collated book block. However, other embodiments are also possible and the collation, rotation and lowering mechanisms can be generalized. The apparatus can have any configuration but usually it will have a configuration that will permit the book block to be brought into substantially perpendicular contact with the cover.

If the book cover is held vertically during processing, the book block would be rotated and brought into contact with the glue strip on the book cover by a horizontal displacement. Similarly, if the book cover is inclined (with its face either above or below the horizontal plane) the book block can be brought into contact with the cover from above or below the horizontal plane as the case may be. However, usually, the approach and contact of the book block with the cover (and glue strip) will be substantially perpendicular.

While the preferred embodiments of the present invention have been described so as to enable one of skill in the art to practice the present invention, the preceding description is intended to be exemplary only. It should not be used to limit the scope of the invention, which should be determined by reference to the following claims.

4. Apparatus according to claim 1 wherein said collator includes means for collating said printed sheets into a book block, and means for aligning the edges of said printed sheets to an end surface of said collator and further aligning said book block with said long edge of said center area.

5

5. Apparatus according to claim 1 and wherein said collator comprises:

collating means which collates and aligns printed sheets into a book block;

clamping means which clamps said book block when collating is completed;

10

rotating means which rotates said book block to a position substantially perpendicular to said book cover after said book block has been clamped; and

aligning means which aligns said book block along said long edge.

15

6. Apparatus according to claim 5 wherein said collating means comprises:

20

a receiver unit for receiving said printed sheets, said unit comprising a base and a plurality of restraining elements mounted on said base, said restraining elements forming a rectangle generally of the same size as said printed sheets;

at least one active element which tamps and aligns said printed sheets when they are within said receiver unit; and

25

a synchronizer which activates the at least one active element when a paper sheet is provided to said receiver unit.

13. Apparatus according to claim 12 wherein said apparatus further comprises a central control unit which controls said on-demand cover printer and wherein said cover printer is in communication with the cover trimmer.
- 5
14. Apparatus according to claim 1 wherein said apparatus is integratable with an on-demand printing machine.
15. Apparatus according to claim 14 wherein said on-demand printing machine is a digital printer.
- 10
16. Apparatus according to claim 14 wherein said apparatus further comprises a central control unit which controls said on-demand printing machine.
- 15
17. Apparatus according to claim 1 which is connectable with a book vending machine.
18. Apparatus according to claim 1 wherein said apparatus further comprises a central control unit which controls at least one of the following: said collator, said cover trimmer, said glue cutter, and said binder.
- 20
19. Apparatus according to claim 1 and further comprising a sensor for determining book thickness, said sensor being in communication with al
- 25

24. An automatic book-finishing apparatus for finishing a book and for use with an on-demand printing machine, the book having a spine of any width, the apparatus comprising:

5 a cover trimmer which trims a book cover, the book cover having a rectangular center area to be coincident with said spine, said center area having a long and a short edge, wherein the length of said short edge is automatically adjustable according to the total number of pages in a specific book;

10 a glue cutter which cuts a glue tape into a glue strip of variable width, said glue strip having a width generally equivalent to the length of said short edge of said center area, wherein said cutter also positions said glue strip on said book cover and aligns said glue strip with said long edge;

15 a collator which collates and aligns printed sheets into a book block of variable width and further aligns said book block with said long edge;

a binder which binds said book along said spine;

a central control unit in communication with and controlling at least one of the following: said collator, said cover trimmer, said glue cutter, and said binder,

20 wherein said finishing apparatus is in communication with said printing machine.

25 25. Apparatus according to claim 24 wherein said collator includes means for collating said printed sheets into a book block, and means for aligning the edges of said printed sheets to an end surface of said

28. Apparatus according to claim 27 wherein said at least one active element is at least two active elements and at least two of the active elements are disposed at about 90° to each other.
- 5 29. Apparatus according to claim 27 wherein said at least one active element is at least two active elements. said at least two active elements comprising a plurality of pneumatic cylinders and said restraining elements are a plurality of pins.
- 10 30. Apparatus according to claim 24 wherein the cover trimmer further comprises a scorer which scores said book cover with a plurality of scores, one of said plurality of scores being aligned co-linearly with said long edge.
- 15 31. Apparatus according to claim 30 wherein said plurality of scores is four scores, an inner pair serving as the edges of said spine and an outer pair serving as hinge-like grooves with which to open the book.
- 20 32. Apparatus according to claim 30 wherein said plurality of scores is a single pair of scores, said scores serving as the edges of said spine.
33. Apparatus according to claim 24 wherein said apparatus is integratable with an on-demand cover printer.

heating element, an RF heating element, an IR heating element and a hot air heating element.

41. Apparatus according to claim 39 wherein said binder further
5 comprises electrical contacts, said apparatus further comprises a means for providing electric current, and said glue strip further comprises a wire, such that when said means for providing an electric current causes a current to pass through said wire when said wire touches said contacts, the current flowing through said wire melts said
10 glue strip.

42. Apparatus according to claim 24 wherein said glue tape is a pressure sensitive glue tape.

15 43. A method for finishing a book, the book having a spine, the method comprising the steps of:

collating, aligning and clamping printed sheets into a book block;

rotating the aligned and clamped book block to a position substantially perpendicular to a book cover;

20 trimming said book cover, said cover having a rectangular center area with a long and a short edge, said center area to be coincident with said spine;

cutting a glue strip from a glue tape, said glue strip having a width generally equivalent to the length of said short edge of said center
25 area;

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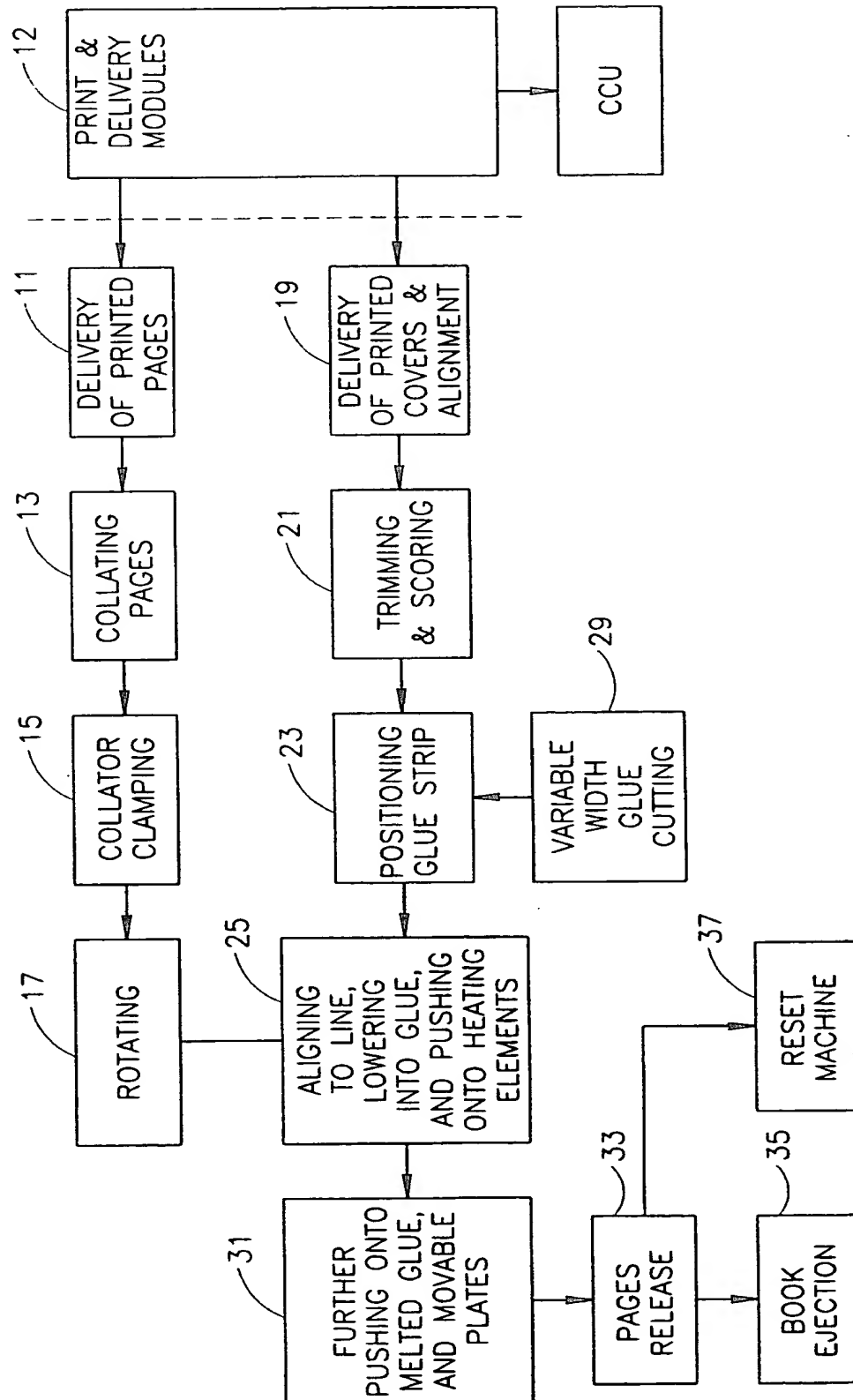


FIG.1

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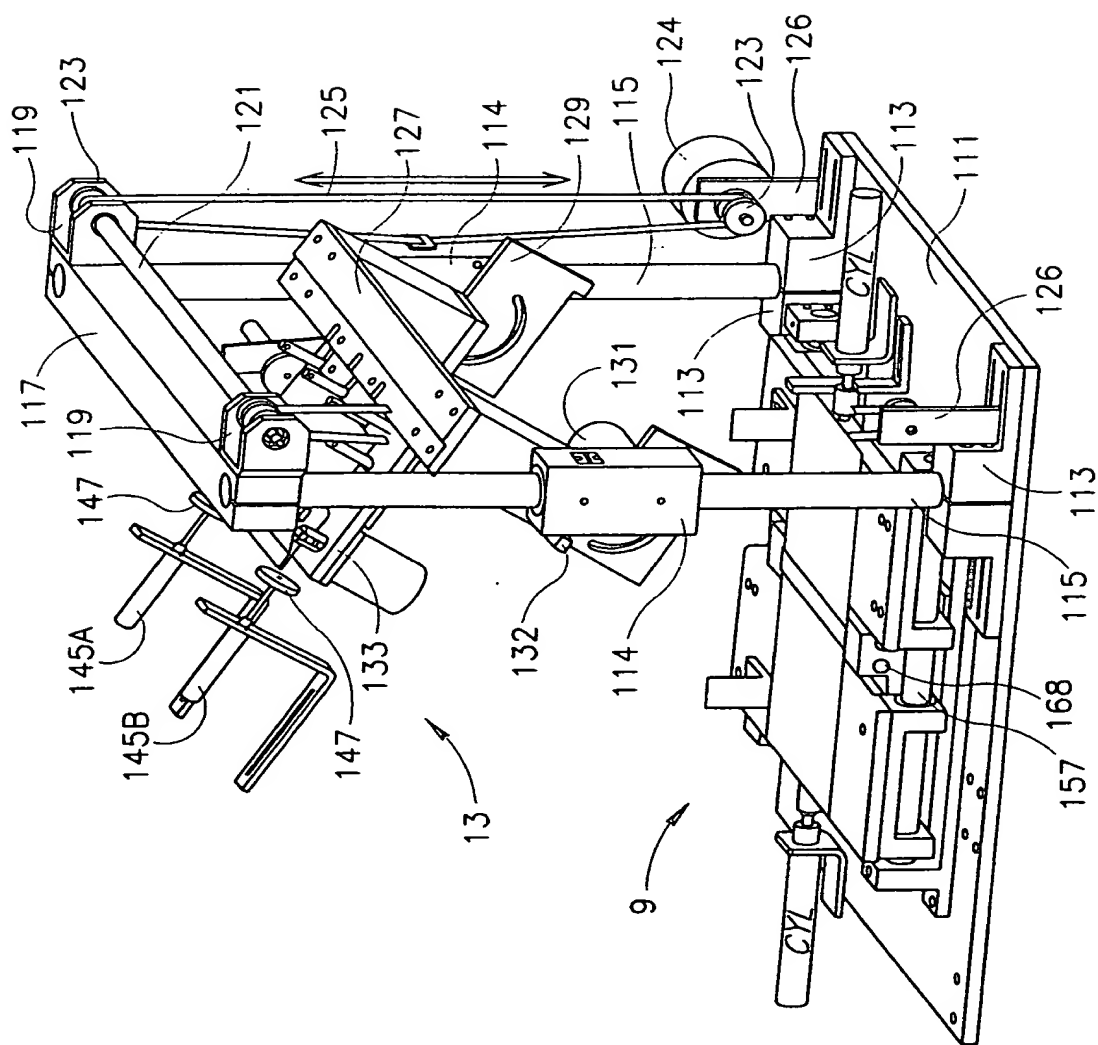


FIG. 3A

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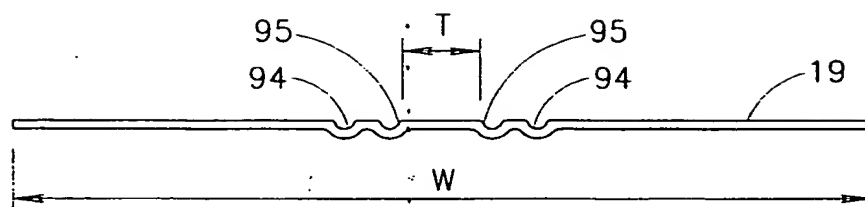


FIG. 4A

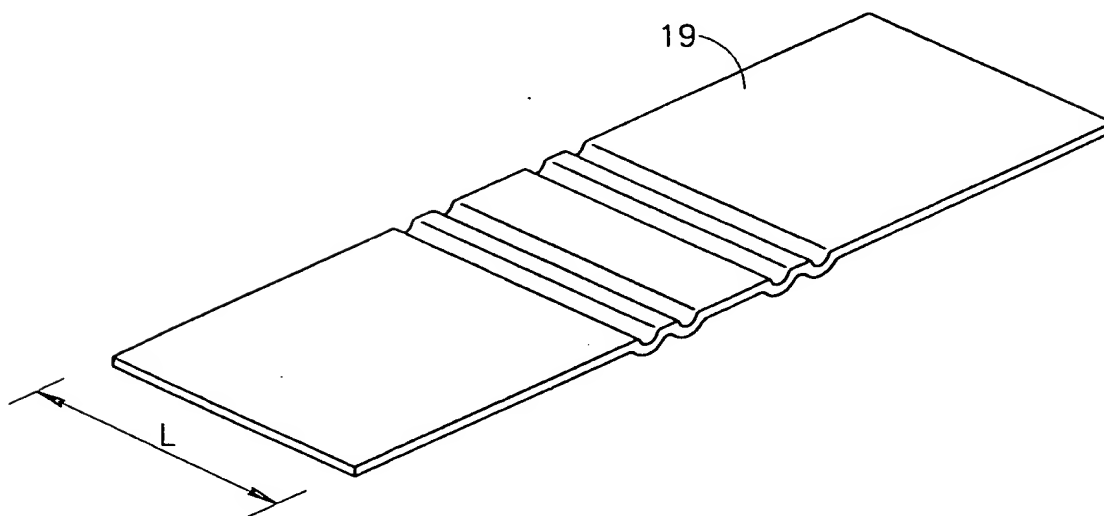


FIG. 4B

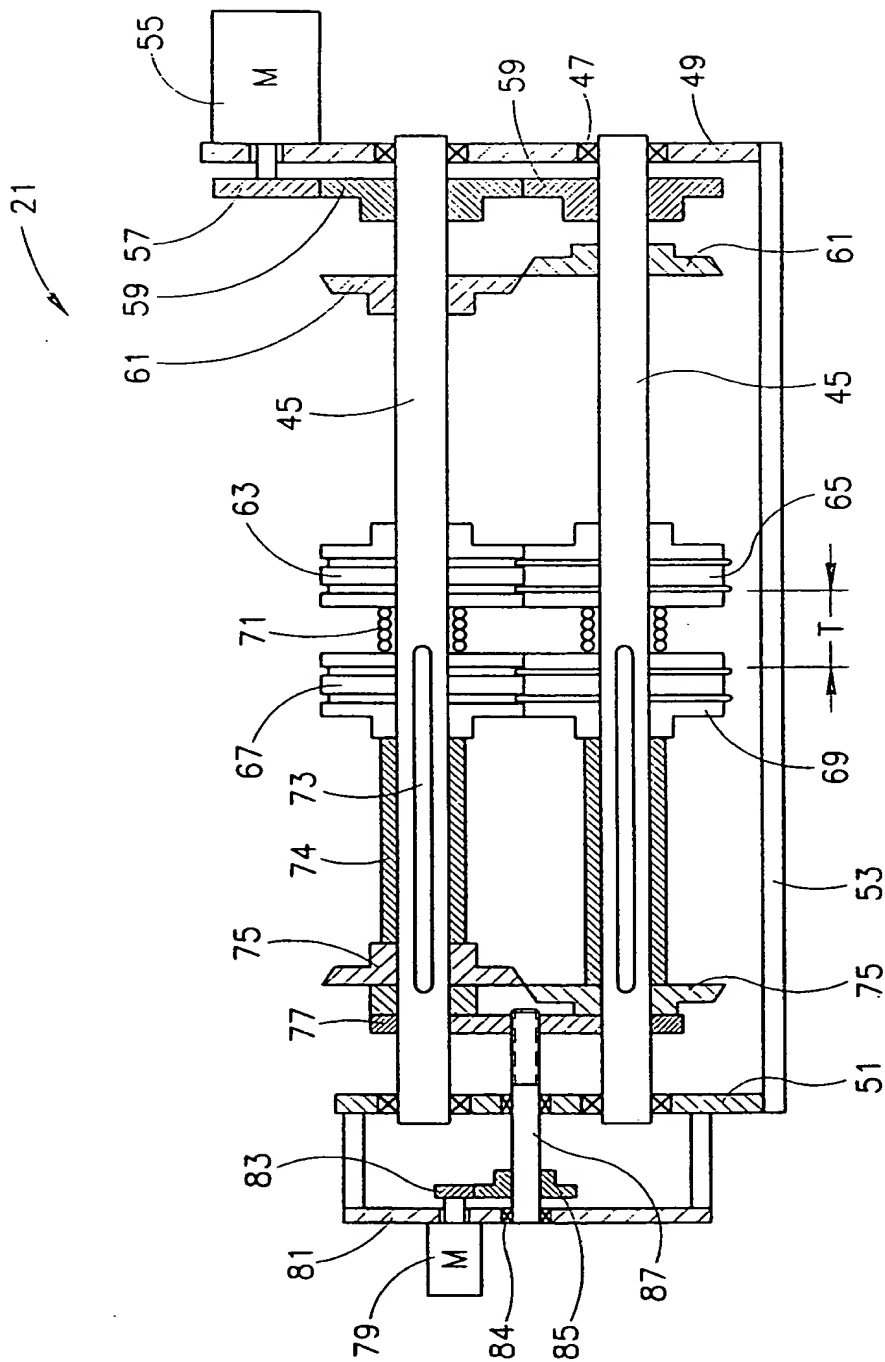
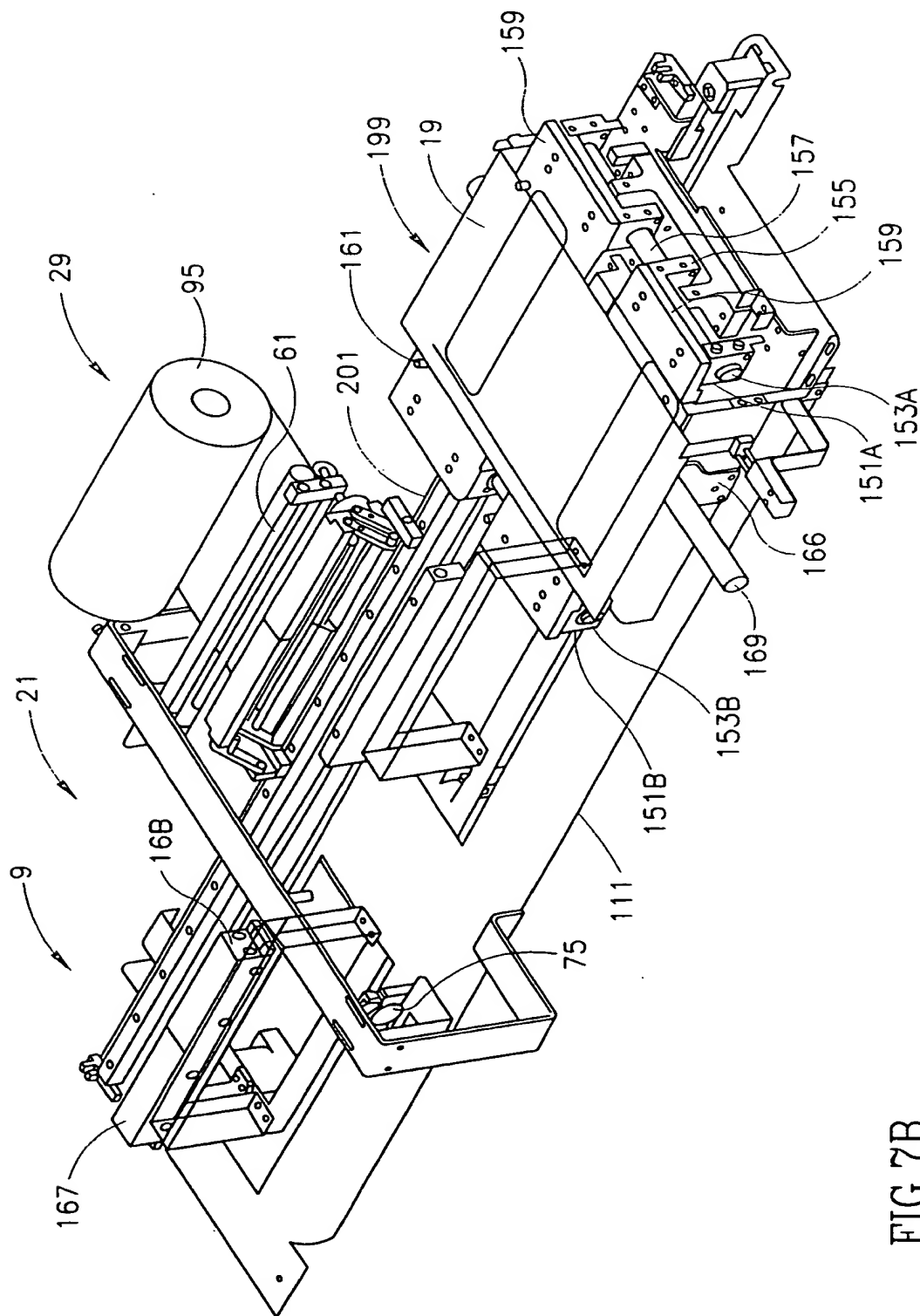


FIG. 6

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11/15

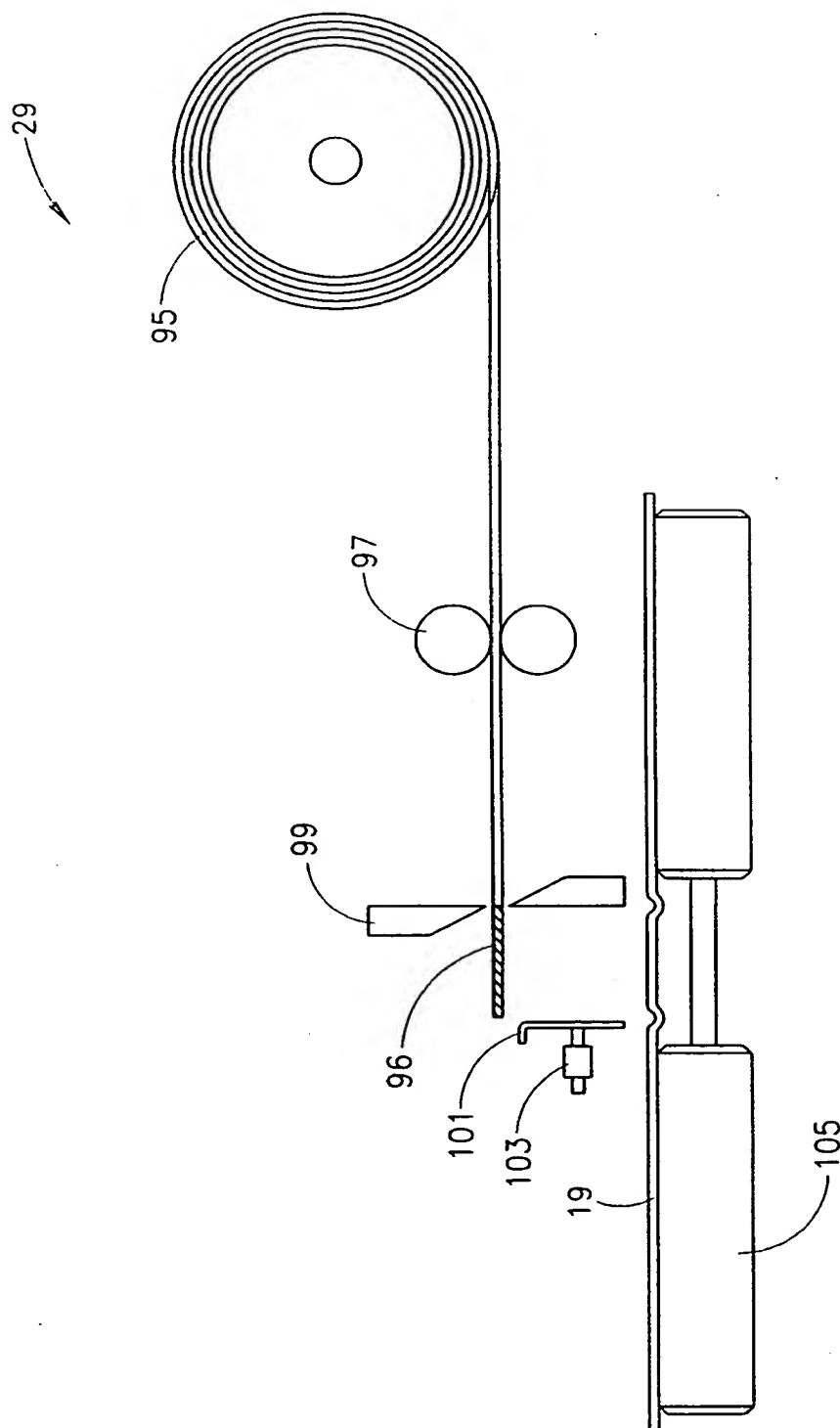


FIG. 8B

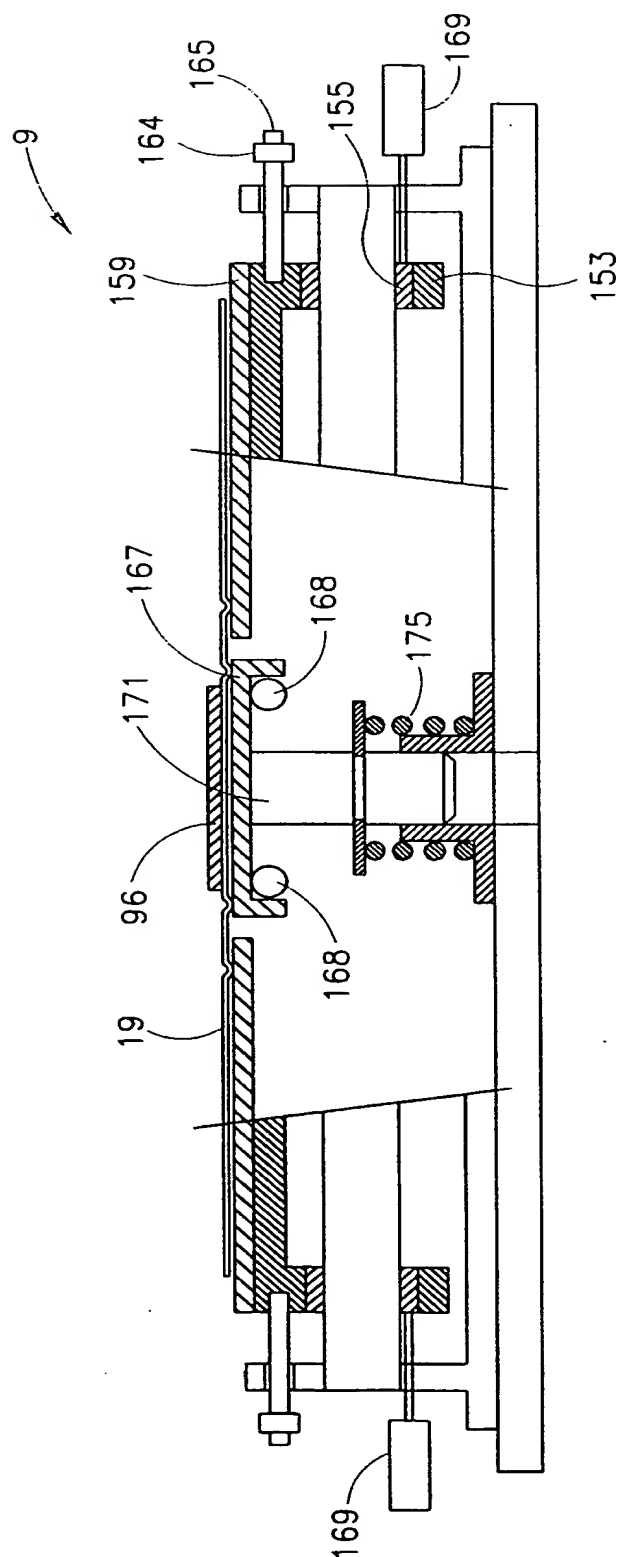


FIG. 10

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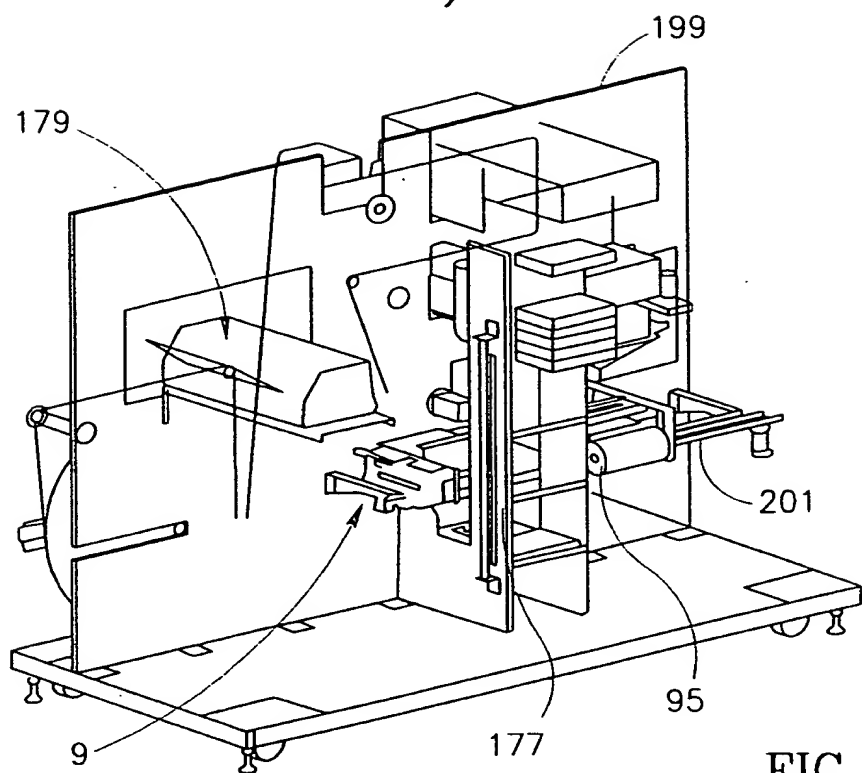


FIG. 12A

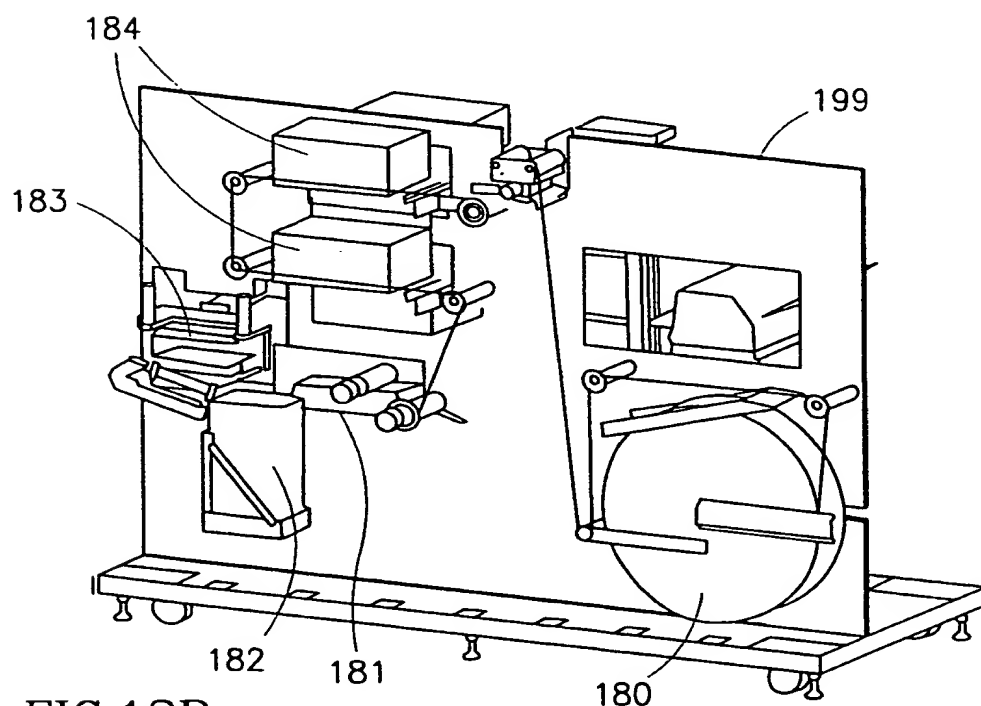


FIG. 12B

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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